1964

A Conventional Assessment of Orthodontic Cooperation as Compared to Interrogation and Polygraphic Testing

Jack Garfield Mann
Loyola University Chicago

A Conventional Assessment of Orthodontic Cooperation as Compared to Interrogation and Polygraphic Testing

by

Jack Garfield Mann

A Thesis Submitted to the Faculty of the Graduate School of Loyola University in Partial Fulfillment of the Requirements for the Degree of Master of Science

June

1964

LIFE

Jack Garfield Mann was born in Lyons, Ohio on October 1, 1933. He graduated from Wayne High School in Wayne, Michigan in June, 1951. He took his predental studies at Long Beach City College where he received an Associates in Arts degree. In June of 1958 he received his Doctor of Dental Surgery degree from St. Louis University School of Dentistry in St. Louis, Missouri. Following graduation he spent three years in the United States Navy and one year in private practice in San Pedro, California. He was accepted for Graduate School in the Department of Orthodontics at Loyola University School of Dentistry, in June 1962. He is married.

ACKNOWLEDGEMENTS

My appreciation and gratitude is extended to all those who have aided in making this investigation possible, and particularly to the following:

I wish to extend my very sincere gratitude to Joseph R. Jarabak, D.D.S., Ph.D., Professor of Orthodontics, Loyola University, who has provided his invaluable guidance and supervision throughout the course of this investigation.

To John Flanagan, Jr., Ph.D., Assistant Professor of Psychology, Loyola University, for spending hundreds of hours assisting this author in proper thesis organization and statistical discipline.

To Gustav W. Rapp, Ph.D., Professor of Biochemistry and Physiology, for his valuable suggestions and guidance.

To Douglas Bowman, Ph.D., Assistant Professor of Physiology, for his assistance in formulating the section on the autonomic nervous system.

To William F. Fallmer, B.S., Examinor, Keeler Polygraph Institute, for his assistance and advice throughout the course of this investigation.

To my three classmates: Joseph Bassler, D.D.S., Ernest Follico, D.D.S., and Michael Gannon, D.D.S., for their cooperative assistance in this thesis construction.

To Robert Lokar, D.D.S., who assisted directly as the interrogator and polygraph examinor.

To my wife, Ryoko, without whose complete understanding, moral support and assistance, this work could not have been possible.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

Introduction

The success or failure of orthodontic treatment is predicated on the level of patient cooperation. Only God and the child will ever know the absolute truth in this matter. It is strange that the question of the level of cooperation has never been seriously investigated by orthodontists. The only recorded attempt to do this was a recent study by Cavanaugh and Campisi of the Orthodontic Clinic of Loyola University. They found, using a "lie-detector", that patients tend to exaggerate when they report how long they wear the headgear and elastics. Cavanaugh and Campisi were not, however, able to estimate the extent of exaggeration.

The purpose of this study was to estimate the extent of exaggeration contained in cooperation charts commonly used by orthodontists. The method was to estimate the level of cooperation by a media common in orthodontic offices. Then to compare the findings obtained by this method with the results found by two more elaborate techniques. The estimates used were: 1) record cards kept by the subject; 2) results of extensive interrogation; and 3) an expert's evaluation of polygraph ("lie-

detector") results.

In the first part of this study, each child was told to record daily the number of hours during which he (she) wore headgear and the number of hours during which he (she) wore intraoral elastics. This is the type of record commonly used by practicing orthodontists. The patients were not warned in advance that these records would subsequently be scrutinized or questioned.

One of the more elaborate estimation techniques involved the use of a third party, a researcher not familiar to the patient, interrogating the child. The interrogation procedure involved gaining the child's confidence. The subject was told that there was nothing to be gained by lying as the results would not be revealed to the clinical orthodontist.

The second of the estimation techniques involved an examination by means of a polygraph machine and an expert's evaluation of these charts. Psycho-physiologic behavior of autonomic origin cannot be controlled by the patient. It is felt therefore that an examination of respiration, heart, and galvonic skin responses would yield a reasonably infallible criterion of patient truthfulness.

CHAPTER II

Review of the Literature: Interrogation, Autonomic Nervous System, and Physiological Detection of Deception

A. Interrogation Procedure

Interrogation procedures have been employed by persons attempting to discover the truth for thousands of years. Over the years, certain procedures were found to be more useful than others in detecting deception. As early as 900 B.C. there were specific instructions for detecting poisoners by their behavior during questioning: "a person who gives poison may be recognized. He does not answer questions, or they are evasive answers; he speaks nonsence, rubs the great toe along the ground, and shivers; his face is discolored; he rubs the roots of the hair with his fingers; and he tries by every means to leave the house."

One interrogation procedure that has often led to the truth is convincing the subject that some infallible test exists. If the subject <u>believes</u> such a thing exists he will reveal the truth even though the "test" is a hoax. For example, the Hindus of India had such a practice: "Suspects were told that a sacred ass would bray when a guilty subject grasped its tail. Prior to the examination the animal's tail would be dusted with lamp black.

Based upon their belief, stemming from interrogation; of the animal's unusual power, the guilty suspect, when sent alone into the chamber with the guilt-detecting ass passed it by without grasping the tail, whereas the innocent subject grasped the tail according to instructions and came away with the lamp black on his hand. The guilty subject on the other hand came from the chamber with clean hands and was in this way revealed."

It is essential for the interrogator to display an air of confidence. This doesn't mean to have a supercilious or bullying attitude, but rather one which will convey to the subject the impression that the interrogator is "sure of himself" and that he "means to find out the truth". The impression must be conveyed to the subject that there isn't really any use of lying. It is known that his original statements aren't correct, and the true values cannot be successfully supressed.

Investigating agencies frequently have employed an interesting tactic in interrogating two subjects involved in the same crime. It is termed simply "play one against the other". There are two versions of this technique. In the first one, the subject enters the interrogation room just as the other suspect is leaving. The first question then put to the new arrival is simply "Well, that other fellow has straightened himself out,

now how about you?" The second method is more elaborate and requires office teamwork. It is used when neither of the two suspects will confess. It follows this pattern: Subject A, after unsuccessful questioning, is told to wait in the reception room while his friend, Subject B, is interrogated. In ten minutes, the secretary, whose desk is near suspect A, is summoned into the interrogation room. Following a thirty minute interval she returns and begins typing a report from her notes. She stops in the middle of the report, turns to the nearby guard and asks "What cellblock is the suspect (B) in now?" Shortly, suspect B is hurried out, and A is returned to the interrogation room. The investigator looks at A and says simply, "Well, what have you got to say for yourself?"

An important rule is that any interrogation procedure must be carried on in private. It has been demonstrated frequently, in the legal profession, that a person is not going to initially confess his prior acts in front of a group of onlookers. On the other hand, if the room is free from outside interruptions and the only other person present is a seemingly understanding interrogator, a subject will often confess.

Another technique used frequently and which works well with teenagers, is the "mutual interest approach". The first twenty

to twenty-five minutes of the interrogation is spent talking about things the subject is interested in: football, tennis, baseball, etc. After the interrogator has established a common level with the subject, the main question to be answered is then asked very firmly. The child by now is off guard and usually answers truthfully.

B. The Autonomic Nervous System

Patient reliability can be assessed physiologically. More specifically, certain autonomic responses to questions concerning cooperation will be reviewed. The three recorded polygraph responses that shall be discussed are: 1) changes in peripheral blood pressure; 2) respiration; and 3) changes in skin resistance.

With the "blood pressure cuff assembly" of the cardiosphygmograph unit, being placed on the brachial artery, we are actually measuring cardiac activity as reflected in an extremity. The blood pressure changes, therefore, would depend on two activities: 1) cardiac stroke-volume; and 2) peripheral resistance.

During emotional stimulation there is increased activity of the posterior and lateral portions of the hypothalmus. This stimulation results in increased activity of the medullary vasomoter center, leading to intense sympathetic discharge and a

marked increase in arterial pressure and heart rate. The sympathetic nerve endings have the capacity to release two hormones in varying amounts: 1) norepinephrine, which potentially causes greater vasoconstriction of essentially all the blood vessels of the body, thereby increasing the total peripheral resistance and consequently elevating the arterial pressure; and 2) epinephrine, which is the more potent of the two in increasing cardiac activity, which results in increasing cardiac rate and stroke volume. Epinephrine also has a strong influence on increasing the metabolic rate of the body.

The muscles of respiration are innervated by somatic motor fibers, with the autonomic fibers being concerned primarily with changes in the amount of constriction of the bronchi and blood vessels. Neurons of the reticular formation extending from the level of the pons to the lower apex of the fourth ventricle are grouped together functionally as a lower respiratory center regulating inspiration and expiration. The sensory drive, apart from conscious control, can be affected by: 1) carbon dioxide content of the blood in direct contact with the respiratory center; 2) afferent impulses coming from the vagus sensory endings in the lungs; and 3) sensory impulses from the carotid and aortic bodies chemoreceptors, to the center by way of the vagus

and glossopharyngeal nerves. It is known that higher levels can alter the discharge of the respiratory centers. The descending pathways to the respiratory centers are not fully delinated, but it is known that neurons arising in certain cortical areas can discharge directly, or by relay in the hypothatmus, to these centers. It is generally believed that these paths are involved in the respiratory responses to emotional situations.

The sudomoter nerves are postganglionic fibers distributed to the sweat glands of the skin by way of the cutaneous branches of the somatic nerves. However, these sympathetic fibers to the sweat glands secrete acetylcholine at their terminals rather than epinephrine or norepinephrine. These fibers are regulated mainly by nuclei in the hypothalmus which are normally considered parasympathetic centers.

C. Physiological Detection of Deception

1. Early and crude uses of physiological reactions for detecting deception.

Many old legends and historic facts are noted in the literature concerning deception. Examples could be discussed that are both interesting and entertaining, but their objectiveness is questionable. Lea, in his treatise on "Superstition and Force" in 1866, discussed at great length the many forms of the

Ordeal used throughout the ages in the detection of deception. The Ordeal technique is not based on any peculiar insight into the physiological processes underlying awareness of guilt; rather it arises out of superstition and religious faith. Of the vast number of Ordeals reported by Lea, two shall be mentioned so as the reader shall better understand more refined methods to come.

The Red Hot Iron Ordeal. This trial was used by the hill tribes of north Bengal, where the accused was told to prove his innocence by applying his tongue to a red hot iron nine times. If burned, he was put to death. (It was felt that a sense of guilt made the mouth dry; although fear would probably do the same.)

The Ordeal of Rice Chewing. This ordeal was extremely popular in Europe throughout the dark ages and was modified to various societies from the basic technique employed by India. The person on trial chews the dry rice with his face to the East, and then spits upon a peepal leaf. If the rice is dry, or the saliva is mixed with blood, or the corners of his mouth swell, or he trembles, he is declared to be a liar.

The Case of the Nobleman's Wife. One very interesting observation was described concerning a nobleman of the middle ages who suspected his wife of infidelity, and told his suspi-

cions to one of his advisors, who agreed to make a test to determine the facts. The advisor engaged the suspected wife in conversation and placed his hand on her wrist. During a brief conversation he mentioned the name of the man suspected by the nobleman, whereupon the lady's pulse quickened; later he brought up the name of the husband with no similar response. It was said that a confession was later obtained.

2. Development of physiological measures and the early use of measuring physiological reactions for the detection of deception.

Clendening reported in his book that Galileo Galilei, while attending church at the Cathedral of Pisa (1581) watching a swinging chandelier, began to formulate an idea for his future development of the pulse counter; matching the regular swings of the chandelier with his pulse. Thus from Galileo's thoughts two ideas sprang; one concerning the timing of the pulse and one the relation of the pendulum's weight and arc to the period of its swing. He began comparing his own pulse under different conditions - after running and at rest - and found it varied, also that other people under varying conditions and ages varied too. So he constructed the first instrument with which to measure the pulse: Galileo's Pulsilogram. It was a very simple thing based

on his string and weight idea. The string wound up on a wheel behind a dial. The dial had a pointer on it. When the pendulum swung synchronously with the patient's pulse the pointer indicated the rate at which the pulse was going.

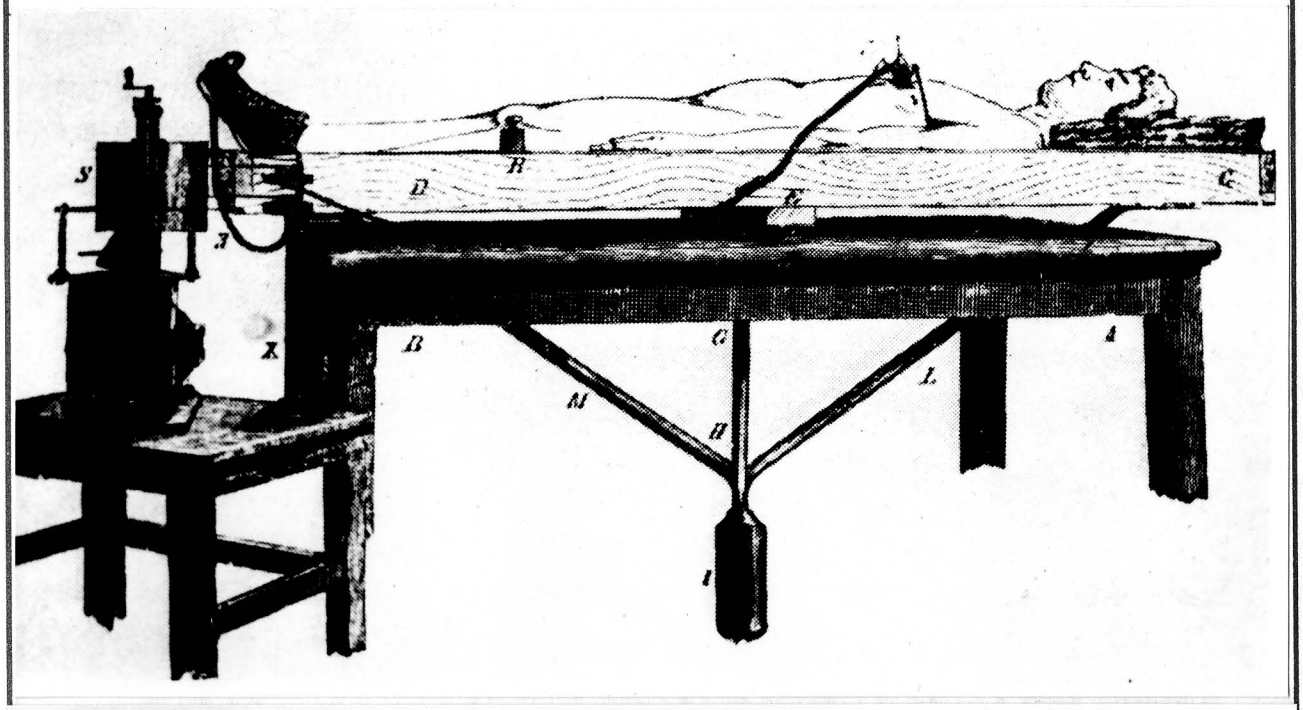
A Roman court physician, Lancisi, in 1728, noted that emotion is related to the functions of the nerves, ganglia, and the coronary vessels of the heart. Emotions are produced, he felt, by more or less forceful heart action. From this he inferred that the characteristics of the mind was derived from the structure and physical changes going on in the body. Today we know that his theory was exactly backwards and that the physical changes in the body are caused by the thought processes. However, the work of Lancisi stimulated much of the later physiological experimentation on the action of the heart during emotion.

An English clergyman named Hales, who beginning in 1733, recorded observations on the blood pressure of dogs. He inserted a glass tube directly into the left auricle and measured its height. Later he did more refined work on does and horses. Many investigators contributed to the development of the current sphygomomanometer. For example, Ludwig in 1847, developed a float on a mercury column and had it write the pressure level on a recording drum. Faivre in 1856, made the first measure of

blood pressure in man. Riva-Rocci 1896, developed the rubber cuff-manometer method. And in 1897, Hill added to this method a means of calibrating pressure.

Much credit should be given to an Italian psychologist Mosso (1885) who, like many other men in this field, didn't invent a "lie-detector". He did make many observations which formed the basis for detection techniques. Mosso recorded many studies of fear and its influence on the heart and respiration. He was able to demonstrate periodic undulations in man's blood pressure caused by the respiration cycle, and he opened new doors with his studies of the circulation of the blood in the brain and its association with fear. He not only performed many carefully controlled experiments on blood pressure and pulse in emotion, but his observations of pallor and blushing, of respiration, of trembling, of facial expression, and of maladies produced by fear are all of unusual significance to research in emotion (Figure 1).

Lombroso was one of the outstanding criminologists of this period. He has been given undisputed credit for putting to practical application some of the observations made by his predecessors. He was the first to explicitly use physiological instruments for the purpose of detecting deception. He also de-



Mosso's Scientific Cradle

This "cradle" was so constructed that a person remaining quiet on it would reveal emotional or other disturbances by the tilting of the plank on which he lay. The top of the table rested on a delicate knife-edge fulcrum (E) and equilibrium of the body was essentially determined by moving the weight (R) to proper setting. To prevent constant swaying of the balance with every small oscillation of respiration, Mosso attached a heavy metal counterpoise (I) which could be screwed up or down (on GH), being fixed vertically in the middle of the plank (DC) and secured by the bars (ML). Thus the smallest oscillations were compensated by the counterpoise, and the balance remained sensitive enough even to "teeter-totter" to the rhythm of respiration. During emotion the blood would "rush to the head" and throw the bed out of balance. This movement would be written on the revolving smoked drum (S) appearing in picture at left. The rubber cuff about the foot was attached by the tube to a tambour, recording pulse fluctuations. A similar recording was obtained by a modest "cardiograph" attached on the chest over the heart.

Figure 1

Photograph: Courtesy of Paul Trovillo

veloped the hydrosphygomograph (Figure 2), a water filled tank into which the hand was immersed and sealed, and in which pulsations of the blood caused a rising and lowering of the water level which was recorded on a smoked drum. This device was used in many cases to aid the Italian police. For example, Lombroso refers to his use of the hydrosphygomograph in proving that a suspect, while innocent of the crime of which he was accused (robbery of 20,000 francs from a railroad), was guilty of another crime (stealing certain documents and passports).

3. More refined methods of detecting deception.

By 1908, the American psychologist Musterberg was urging the practical application of experimental psychology. He had many ideas for applying psychological principles which have not been superseded. One method was advocating the application of the word association technique for diagnosing guilt.

Benussi (1914) reported partial success in detecting deception by the "inspiration-expiration" ratio. He measured the recorded respiratory curves from a pneumograph and found that if length of inspiration were divided by length of expiration the ratio was generally greater before answering truthfully than afterwards. However in 1921, Benussi expressed doubts about the

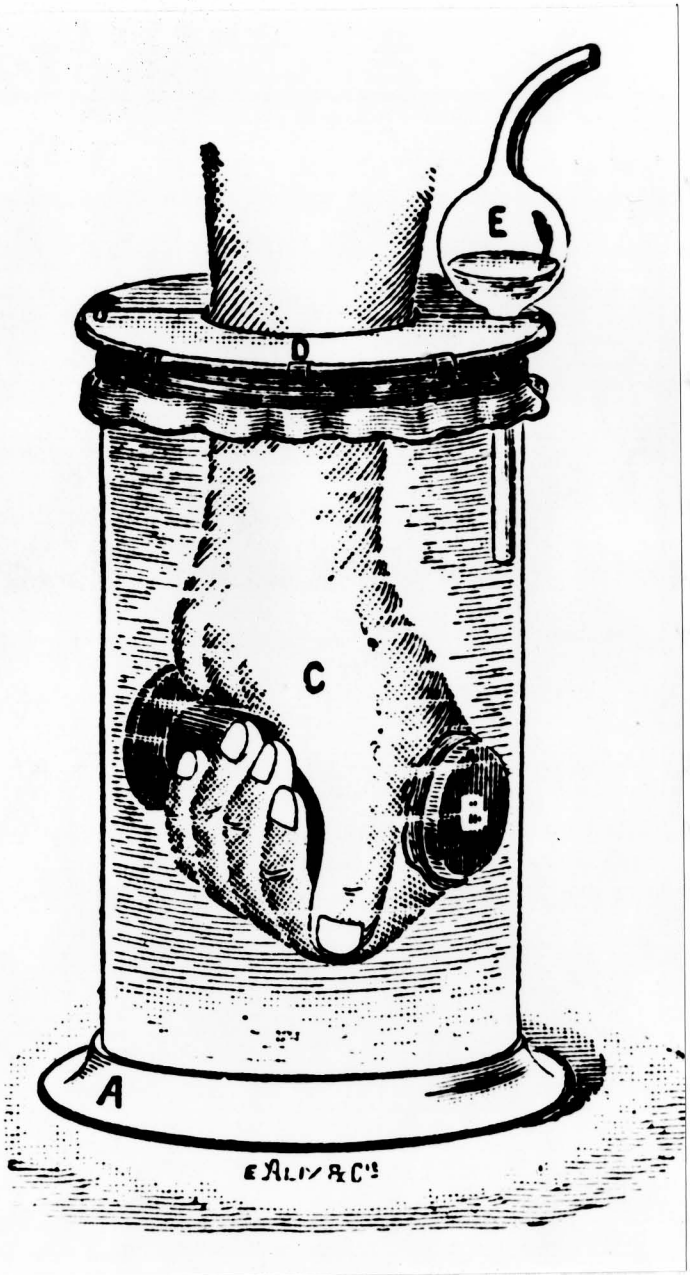


Figure 2

Lombroso's Hydrosphygomograph

Photograph: Courtesy of Paul Trovillo

reliability of this index for detecting deception.

Darrow (1910), demonstrated a way for determining the absolute systolic and diastolic blood pressures. Later he concluded that this refined measurement of absolute pressure is not needed for purposes of detecting deception. Darrow devised a very elaborate behavior research polygraph (Figure 3).

Larson (1920), did much to develop the applied use of the polygraph for the detection of deception. In 1921, using an Erlanger sphygmomanograph and pneumograph, he questioned some four hundred police suspects. He reported a high degree of accuracy in detecting deception. It is reported in the literature that Larson felt "that all deception tests should be part of an analysis of the crime setting integrated with each individual personality analysis. Neither medical nor criminological training alone is a requisite but a combined staff consisting of the investigators, the examiner ideally with legal psychological training, and a psychologist and a licensed physician. The last three named should be present throughout every examination".

Keeler (1930), became a member of the staff of the Chicago Juvenile Research Laboratory, and for eight years utilized the blood pressure, pulse, and respiration patterns for detecting criminal guilt. He and his associates reported successes in

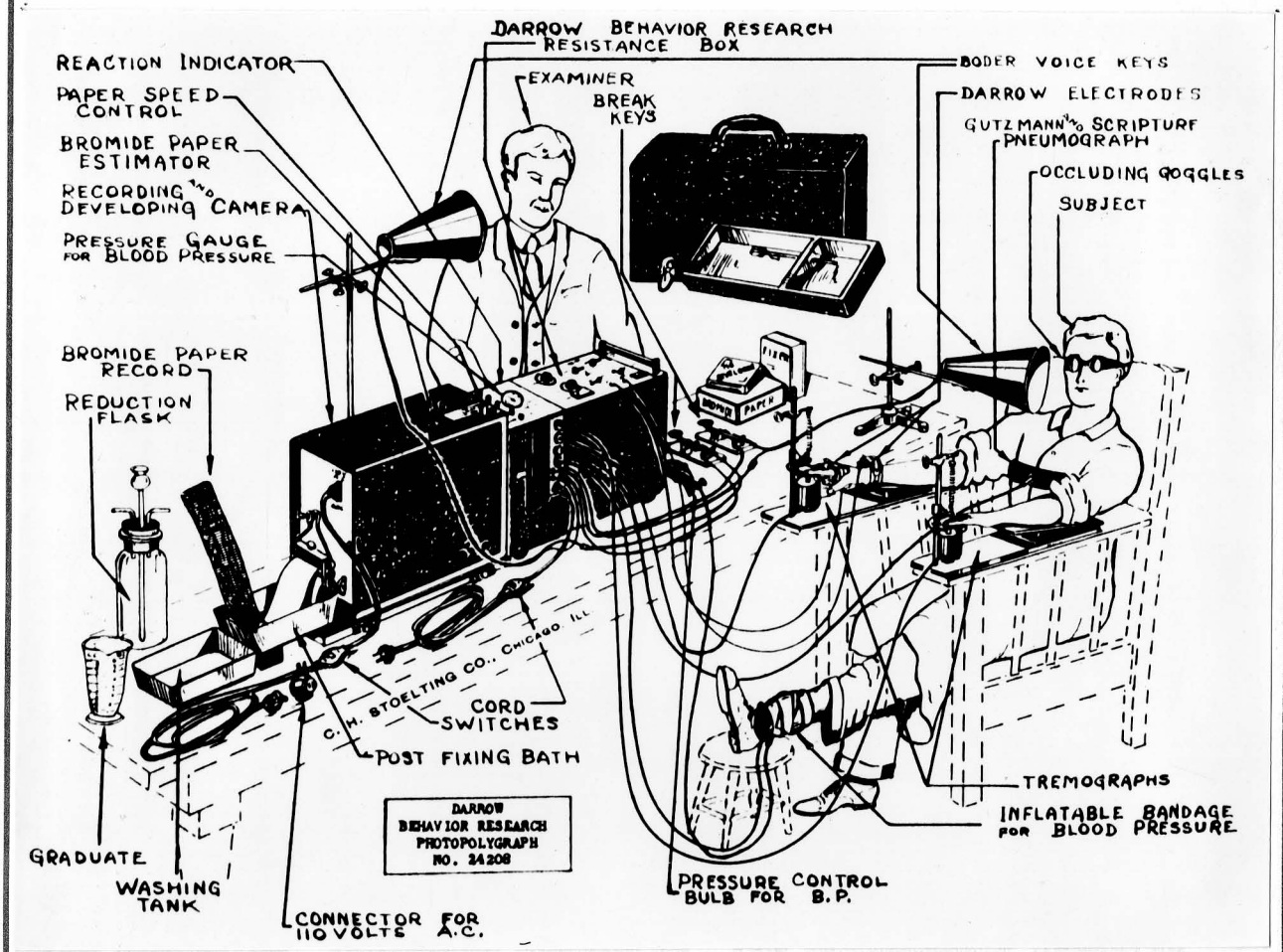


Figure 3

Darrow's Behavior Research Polygraph

Photograph: Courtesy of Paul Trovillo

diagnosing deceit in experimental cases 85 percent of the time, and in obtaining confessions from criminal suspects in 75 percent of the cases in which the polygraph records indicated deception.

Keeler, Larson, Darrow and the others did not really invent a "lie-detector machine". They used existing physiological instruments for the applied purpose of detecting emotional responses during interrogation.

"Lie-detection" is the collection of standard physiological data under controlled conditions that enable the operator to draw inferences about attempted deception. Circumstances under which the data are recorded (room, wording of questions, elimination of distractions, etc.) are of crucial importance.

4. Present day uses of the polygraph.

The use of the polygraph for the purpose of detection has become wide spread. Many major companies now require all new potential employees to take a preemployment examination. Bonding companies, insurance companies, law enforcement agencies, banks, etc., are increasing their use of the polygraph.

5. Polygraph uses in dentistry.

It was in 1958 that the first research in dentistry utilizing the polygraph was reported. At that time Lewis and Law

conducted a study relating autonomic responses to dental stress. The responses studied were: heart rate, external face and hand temperature and galvanic skin response. It was a test designed to determine if the presence of the parent influences the autonomic reactions of children to a routine dental prophylaxis. Their findings indicated that the presence or absence of the parent made no significant difference in autonomic responses of those children.

In 1961, Lewis, Law and Roder, set up another stimulus reaction whereby they could record the autonomic responses of the dentist to the presence or absence of the parent in and then out of the operatory. No appreciable difference in autonomic responses was noted.

Also in 1961, a Japanese orthodontist, Ando, studied galvanic skin responses of patients undergoing various routine clinical procedures. His findings indicate that female patients give less response than males; and that the older patients give less response than do the younger patients.

Cavanaugh and Campisi (1963), performed a study on truthfulness about levels of cooperation on orthodontic patients. They recorded: heart rate and blood pressure, respiration, and galvanic skin response. They found that the patients tended to

exaggerate about the amount of time they wore their headgears and elastics. They did not examine the magnitude of this exaggeration.

CHAPTER III

Methods and Materials

A. Selection of Patients

The subjects for this study were twenty-four children; eleven boys and thirteen girls, randomly selected from the patients at the orthodontic clinic of Loyola University. Their ages ranged from eleven to fifteen years. All patients were required to wear both extra cranial headgear and intraoral elastics. The patients were encouraged to wear the headgear as much as possible (even to school). They were told to wear their elastics all the time except when brushing the teeth or eating. The patients were instructed to change both the headgear elastics, and intraoral elastics at least three times a day to achieve the desired tooth movements. The headgears used in this study were forty percent of the cranial type and sixty percent of the cervical type.

B. Materials

1. Time records

A time card of the type in common orthodontic use was given to the patients (Figure 4). Complete instructions as to its use

DATE	SLEEP HG hrs.	SLEEP EL hrs.	MORNING SCHOOL EL hrs.	AFTERNOON SCHOOL EL hrs.	BEFORE DIN. HG hrs.	BEFORE DIN. EL hrs.	AFTER DIN. HG hrs.	AFTER DIN. EL hrs.	TOTALS HG hrs.	TOTALS EL hrs.	AVERAGES 3 dys	AVERAGES 1 wk.

Figure 4

Time Card

was given to both the child and parent. Accuracy was emphasized. There was no mention of minimum or maximum hours; simply be honest and record everything daily. These cards were collected each three weeks, checked, and a new one recirculated. This data collection continued for six months.

2. Polygraph equipment.

The Keeler Polygraph, model 302C was used in this study (Figure 5). It is designed to record physiological changes which accompany the effects of questioning of the subject. The 302C contains a cardiosphygmographic unit for recording changes in blood pressure (based on stroke volume and peripheral resistance) (Figure 6); a pneumograph unit for recording amplitude and pattern of respiration (Figure 7); and a galvanometer unit to record changes in skin resistivity of the person being interrogated (Figure 8).

3. Polygraph examination room.

A four by nine feet room, lined with acoustical tile was used as a polygraphic testing center and for secondary interrogation. This isolated the subject and provided privacy with a minimal number of outside distractions. This room had a ventilation system and indirect fluorescent lighting. The subject was

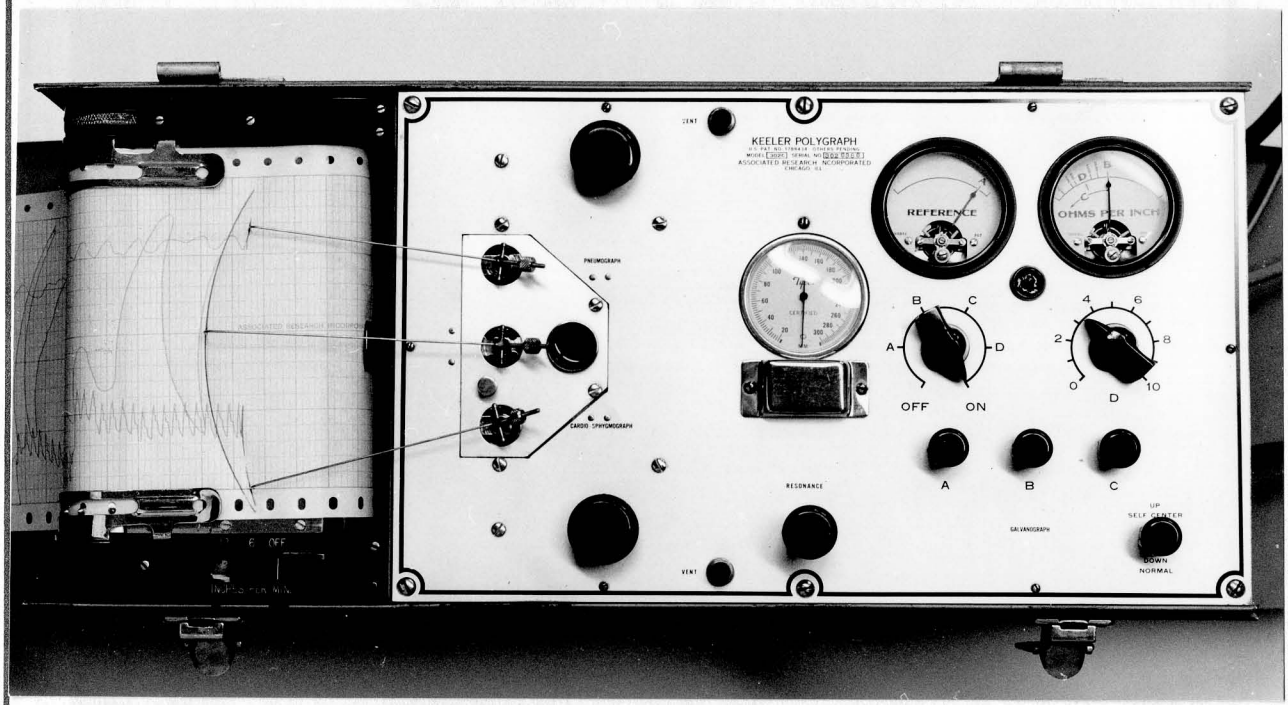


Figure 5

Keeler 302C Polygraph Unit

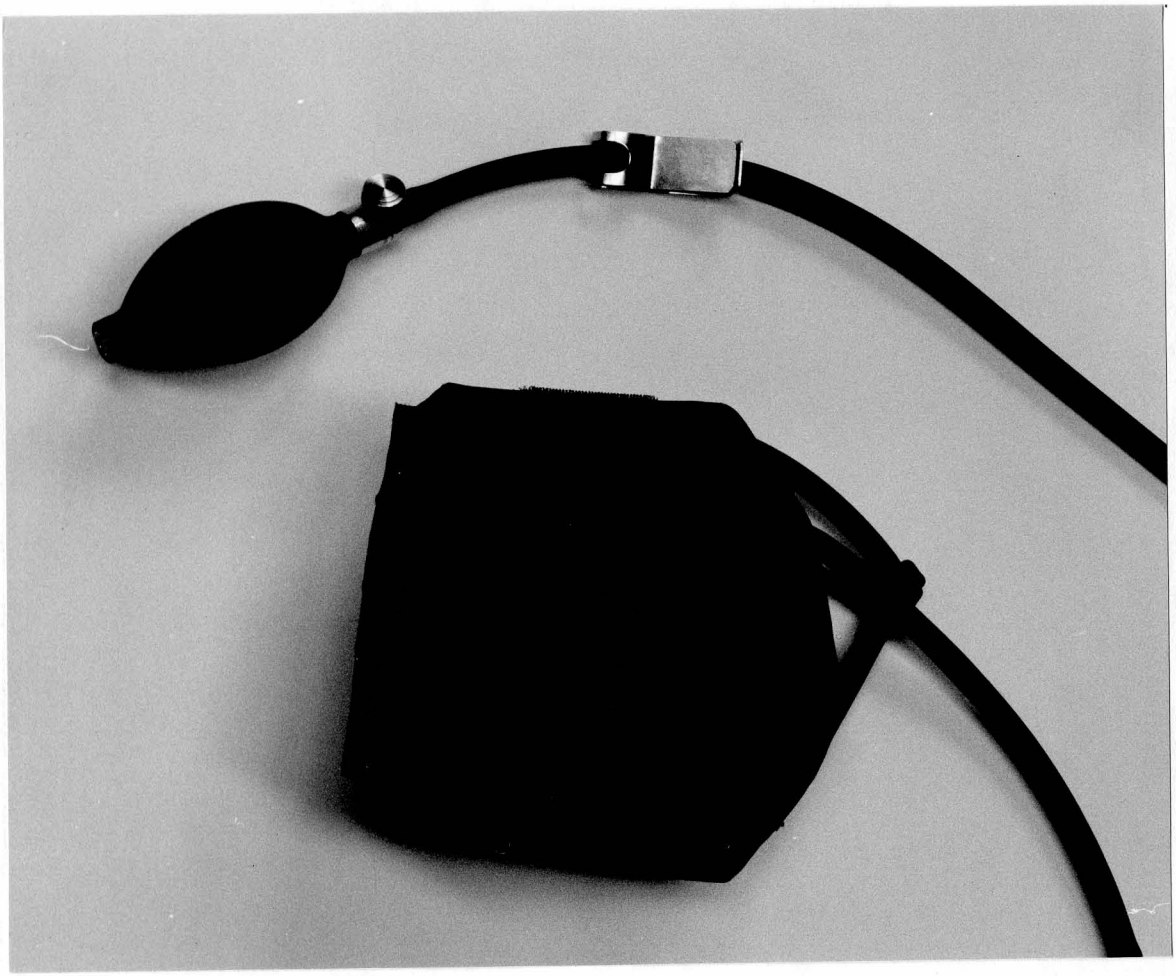


Figure 6

Blood Pressure Cuff Assembly

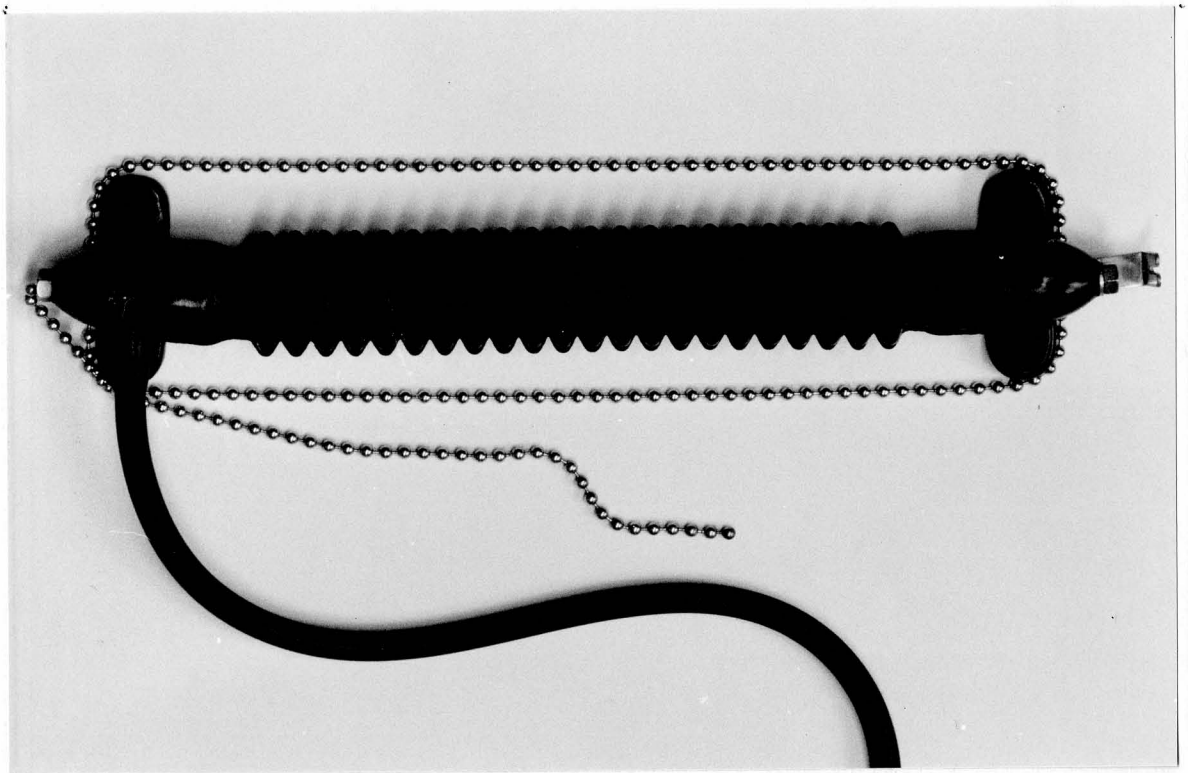


Figure 7

Pneumograph Assembly

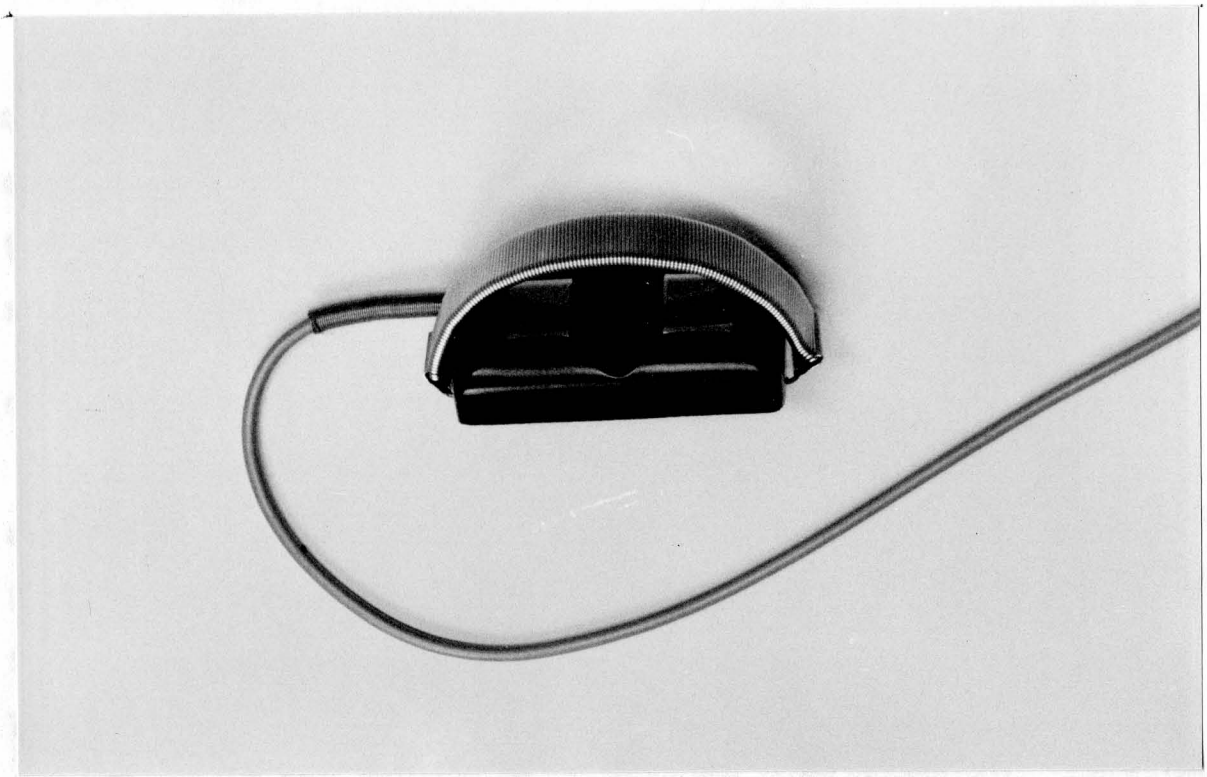


Figure 8

Hand Electrode Assembly

seated in a large comfortable chair. The chair had wide arms which supported the patient's entire forearms and hands (Figure 9).

4. Interrogation room.

The primary (initial) interrogation was done in a room adjacent to the polygraph room. This interviewing area also was quiet and free from distractions. Any telephone, pictures, or the presence of a large desk or table (separating the subject and interrogator) was eliminated.

C. Experimental Procedure

The patient was brought into the interrogation room and seated in the chair provided. The subject was asked to cooperate further in this study. The interrogator (a researcher not familiar to the patient) assured the subject that all answers would be kept in confidence.

Three of the subject's time cards were selected. Each card covered a period of three treatment weeks. The first card covered a period in the third month of treatment, the second covered a period in the sixth month of treatment, and the third card covered a period in the ninth month of orthodontic treatment.

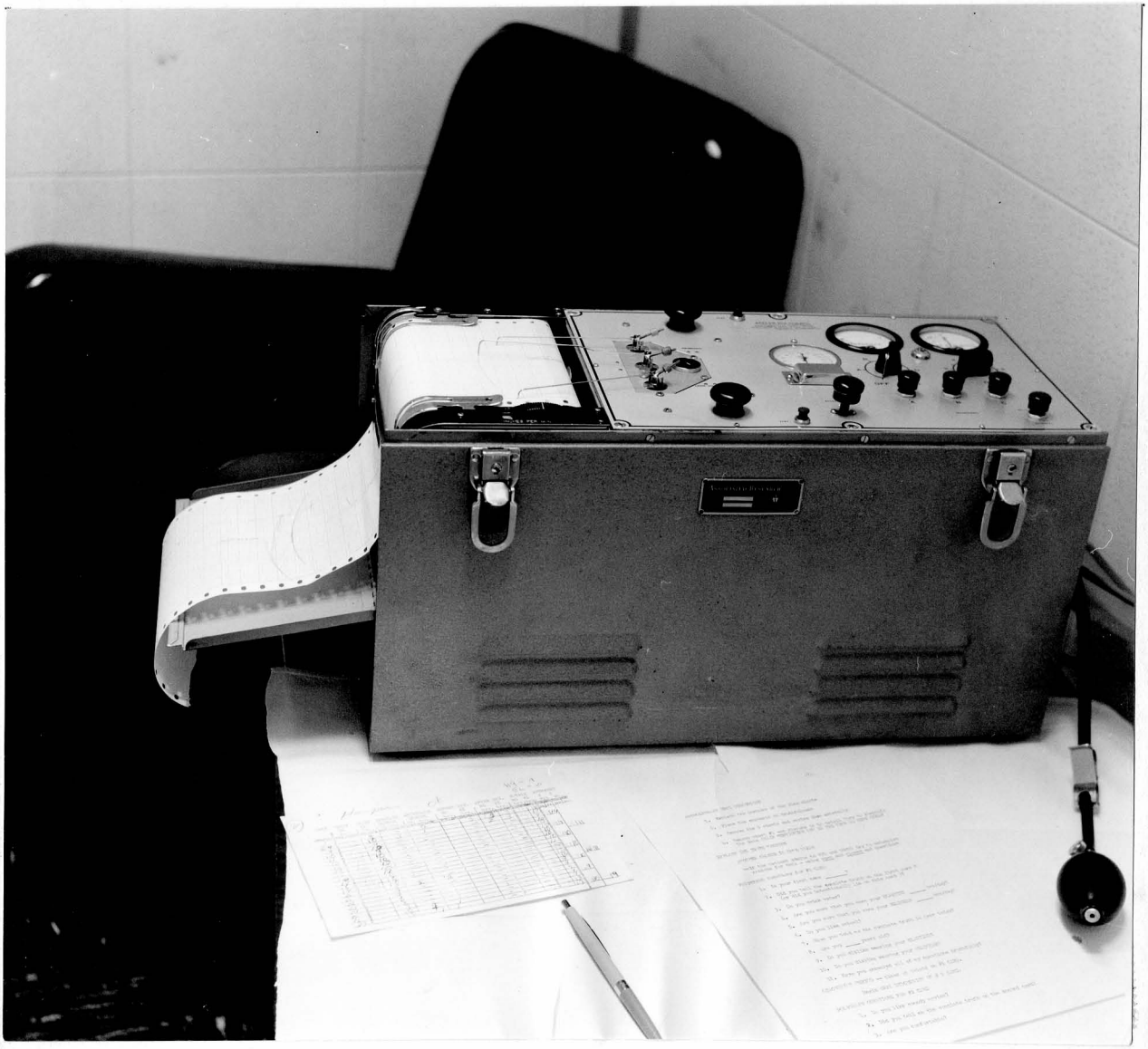


Figure 9

Polygraph Examination Room

The pattern of questioning ran along these lines:

1. The purpose of the time charts was again explained to the patient.
2. Emphasis was placed on truthfulness especially now during this interview and testing period.
3. Emphasis again placed on the confidential nature of these questions and answers.
4. The patient was asked to carefully study the first of the three time cards.
5. Again the child was told that if he or she is withholding any information that "now is the time to come clean".
6. The polygraph or "truth machine" was explained as to its primary function and purpose.
7. The patient is again asked if he is sure that all answers are correct.
8. If admissions were given and the operator noted variations, during this time period, he would try to establish reasons for these "ups and downs" by way of open and closed end questions.

After the operator was convinced he had done as much as he could to persuade the subject to tell the truth, the patient was

shown into the polygraph room and prepared for testing (Figure 10).

In order to impress the patient that this machine was really accurate, a card trick was employed. The subject was told to select a card, remember it, and return it to a stack of ten cards. The polygraph machine was then activated. The patient was told only to view, not to respond orally, as he was shown the cards one by one. At the end of this sequence the polygraph responses always clearly showed the card that the patient was concentrating on. (To avoid any possible chance of a mistake, and allow the patient to think that this "magic machine" wasn't really magical, a marked deck, unknown to the patient, was used.)

With the subject properly impressed with this "unbeatable truth machine" the interrogator proceeded with the standard test questions (Figure 11). (These polygraph questions were planned and formulated with the advice of experts.) All subjects were instructed to remain still, look directly ahead, and answer all questions simply "yes" or "no".

1. Is your first name _____ ?
2. Did you tell the complete truth on the first card?
3. Do you drink water?
4. Are you sure that you wore your ELASTICS ___ hrs/day?

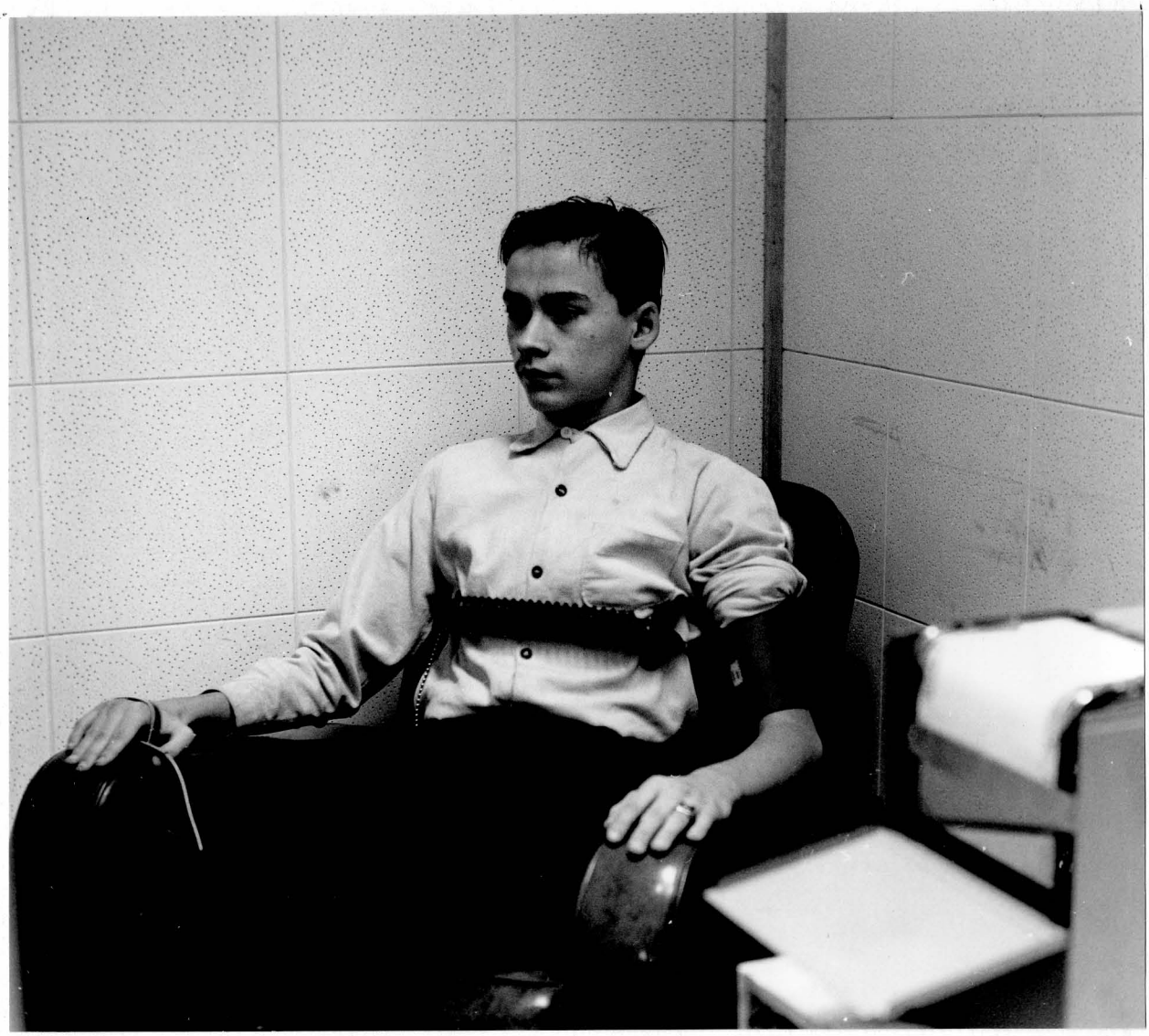


Figure 10

Attachments Connected to the Patient

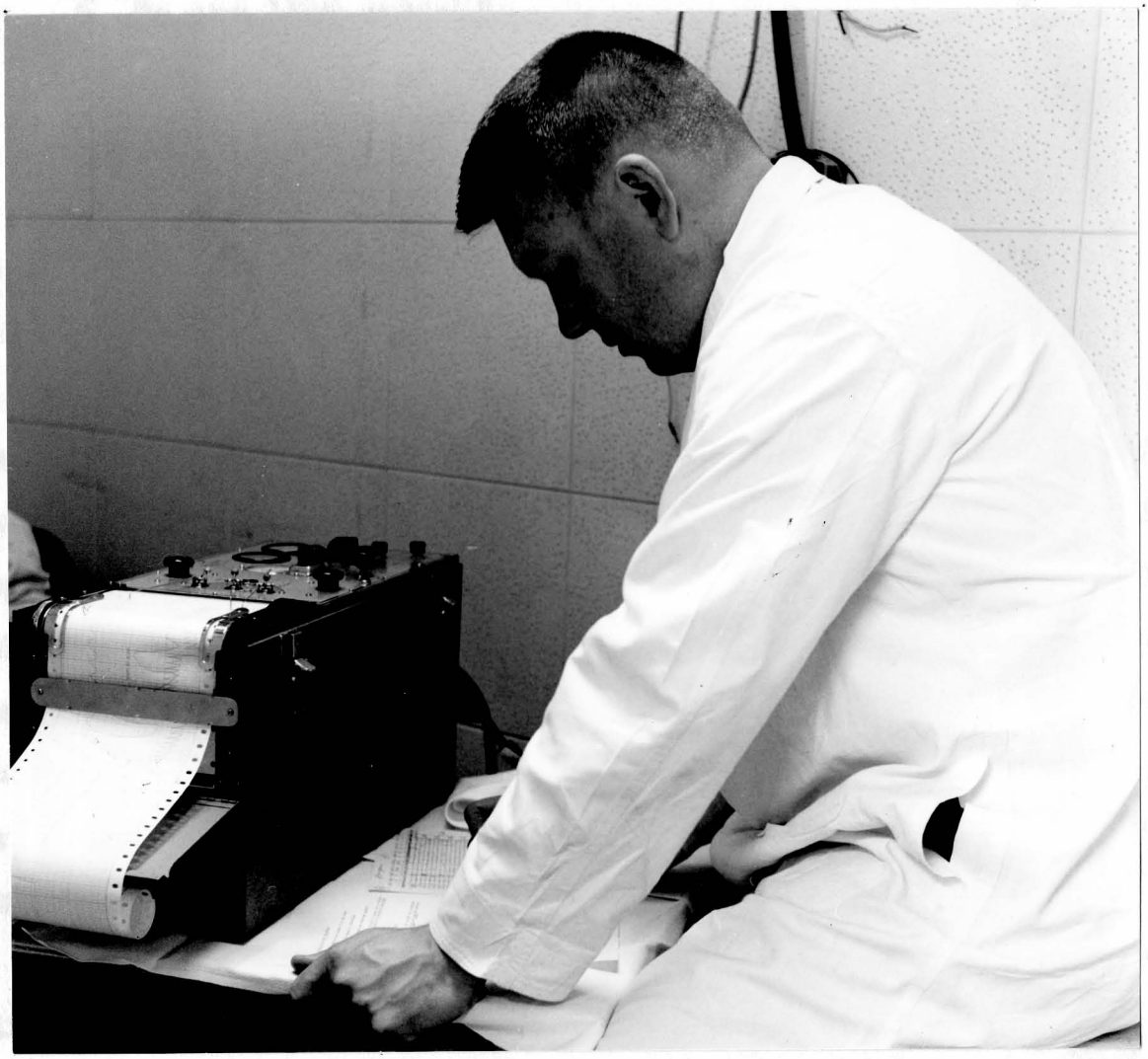


Figure 11

Examinor Giving A Polygraph Test

5. Are you sure that you wore your HEADGEAR ___ hrs/day?

6. Do you like school?

7. Have you told me the complete truth in here today?

8. Are you ___ years old?

9. Do you dislike wearing your ELASTICS?

10. Do you dislike wearing your HEADGEAR?

11. Have you answered all of my questions truthfully?

At the conclusion of this test the operator vented the blood pressure cuff assembly around the arm. The investigator was not an expert at interpreting polygraph charts. However, if in his opinion, the chart indicated attempted deception he again urged the subject to think carefully and help clear up irregularities on the chart. If several "doubtful" reactions were present the test was repeated. When the interrogator was convinced he had a "clean chart" he then gave the subject a short rest period and began on the next time card.

The same basic procedure of emphasizing the truth as outlined for the first card was repeated for this second card. Following an oral discussion the polygraph assembly was reactivated and the second series of polygraph questions began:

1. Do you like comedy movies?

2. Did you tell me the complete truth on the second card?

3. Are you comfortable?

4. Are you sure you wore your ELASTICS ___ hrs/day?

5. Are you sure you wore your HEADGEAR ___ hrs/day?

6. Have you lied to any of my questions?

At the end of the second polygraph test the arm cuff was deactivated and another short rest period was given. The examinor again reviewed the polygraph charts to clear up any irregularities. After being satisfied that the subject is responding favorably, he proceeded to the next card.

Using the same procedure as before, the figures on this third and final card were examined. The questions were as follows:

1. Have you now told me the complete truth?

2. Did you tell the complete truth on CARD number 2?

3. Do you like soda pop?

4. Are you sure you wore your ELASTICS ___ hrs/day?

5. Are you sure you wore your HEADGEAR ___ hrs/day?

6. Do you like movies?

7. Was Dr. _____ your doctor?

8. Do you think that by now I can find out if you are really telling the truth?

Following this series of polygraph tests, the patient was

again allowed a few minutes to relax. The interrogator then questioned the patient about, if noted, reasons for sectional rises or falls in the cooperation level. Finally, the operator probed, if appropriate, for the reasons why the subject was untruthful in filling out the time card.

All of the charts were then examined by a polygraph expert, and those cases in which he suspected that the subject was not "coming clean" were retested by him.

D. Chart Interpretation

In the analysis of the physiologic responses, as recorded on the polygraph, the tracings of the pneumograph, galvanograph, and the cardiograph were evaluated (Figures 12 and 13). If there is deception the recording will show a variation from the normal pattern in at least one of the three recorded responses. If deception is very evident we may see a change in the pattern of all three responses. There are some basic items to examine in chart evaluation to determine if deception is present:

1. Galvanograph tracing. We would expect to see, in deception, a noticeable response in this tracing. Any decrease in the skin resistance (from sweating) will result in an upward shift of the recording pen. In Figure 12, the galvanograph tracing "B" is

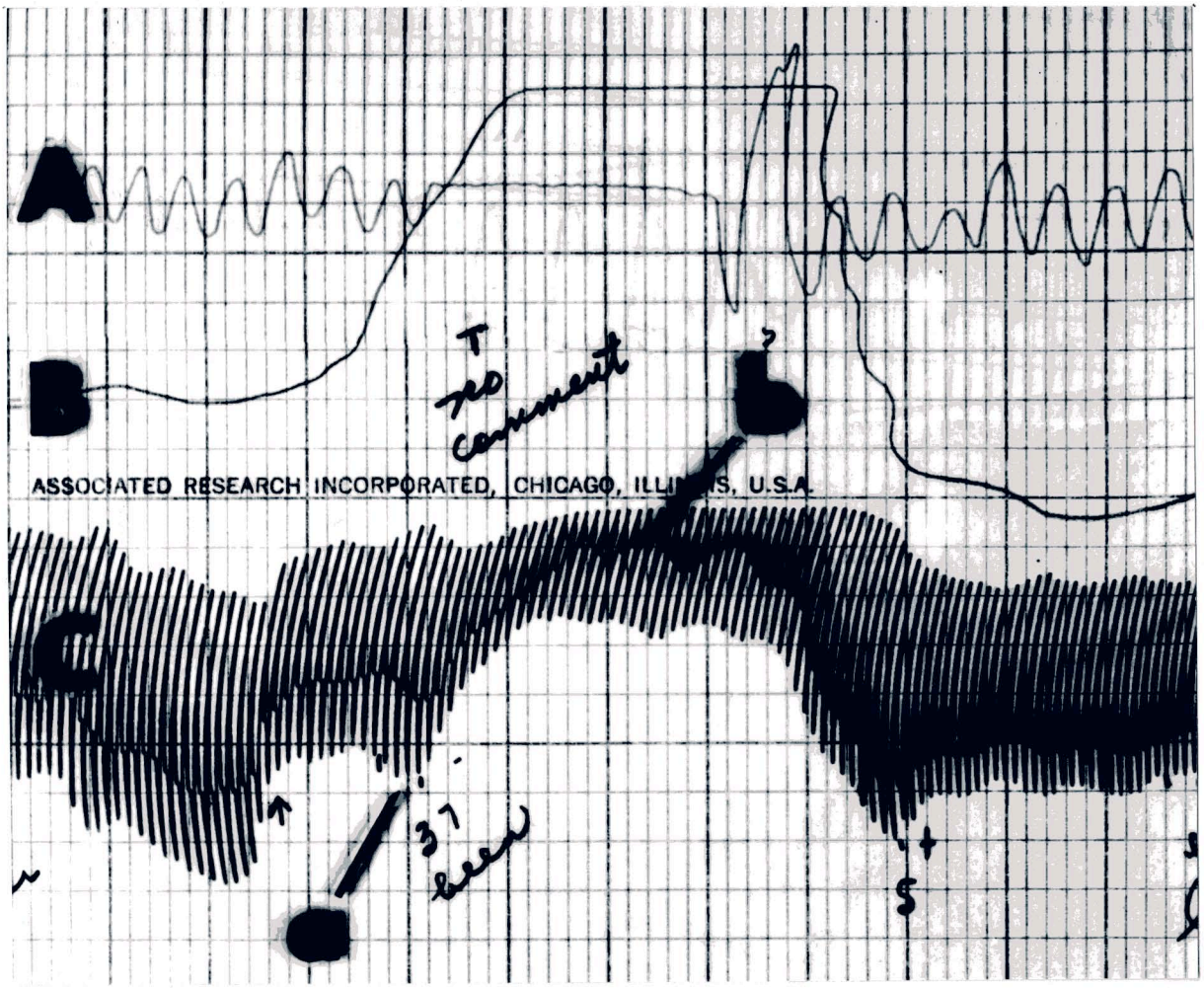


Figure 12

Polygraph Chart Showing Deception

A Pneumograph tracing
B Galvanograph tracing
C Cardiograph tracing

a Question evoking positive deception responses in all three recordings
b Dicrotic notch elevation

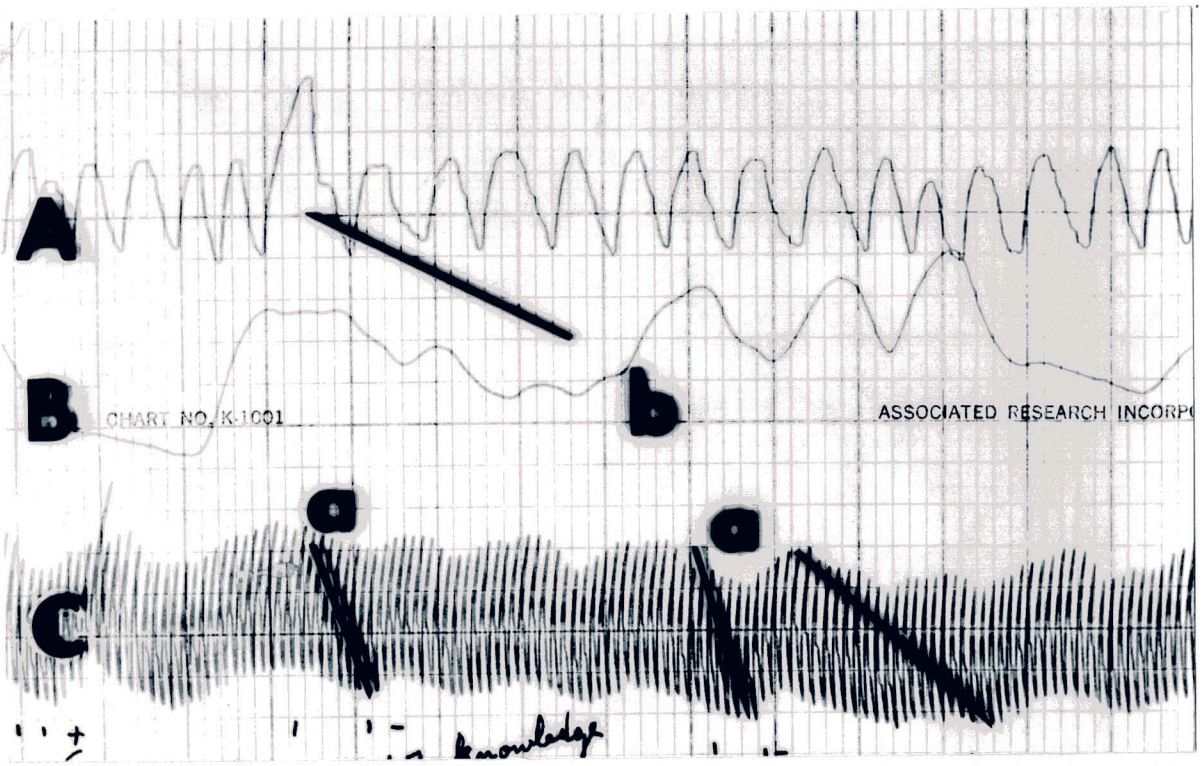


Figure 13

Polygraph Chart Showing No Deception

A Pneumograph tracing
B Galvanograph tracing
C Cardiograph tracing

a One irrelevant and two relevant questions
b "Sigh"

elevated as a verbal stimulation is given at "a" concerning whether or not the patient has been telling the truth.

2. Pneumograph tracing. Here the examinor would expect to see either a change in the rate or amplitude of the patient's respiratory pattern. In Figure 10, the pneumograph tracing "A" is altered in both ways from a verbal stimulus at "a"; we see in this tracing that the patient actually stopped breathing temporarily (apnea). Following this apnea (Figure 12), the patient took a deep breath and soon returned to a normal breathing pattern.

3. Cardiograph tracing. In this tracing, deception may manifest itself in any or all of three ways: the rate may alter; the amplitude of the recording pen may change from the baseline; and we may see a change in position of the dicrotic notch. In Figure 12, the cardiograph line "C" indicates that when the verbal stimulus is given at "a" we see all three of these deception indicators: a change in rate; amplitude; and dicrotic notch elevation "b".

Care must be exercised that any abnormal movements are noted at the time of the recording. If the patient moves his arms, sighs, coughs, sneezes, or talks, these all will result

in an irregular tracing.

The questions must be properly spaced to give the individual's responses a chance to return to their normal base line, before asking the next question. In Figure 13 we note that this subject appears to be free from any deception as three questions, asked at 'a' produce no appreciable change in any of the recordings; ('b' is not a reaction to the verbal stimulus, but rather a sigh).

CHAPTER IV

Experimental Results

With the random selection of twenty-four orthodontic patients, eleven boys and thirteen girls (all wearing headgears and elastics), the following results were obtained from this study on cooperation.

A. Hours Reported

1. Time Card Reports (Table 1)

Card 1 - covered the third month of treatment. Indicated that this group wore their headgear an average of 12.2 hours per day, and wore their elastics an average of 20.9 hours per day.

Card 2 - covered the sixth month of treatment. During this period the patients recorded that they wore the headgear an average of 12.0 hours per day, and the elastics 19.4 hours per day.

Card 3 - covered the ninth month of treatment. The patients reported that they wore their headgear 11.3 hours per day, and the elastics 19.4 hours per day.

TABLE 1

Time Card Reports
(hours)

Subjects	Headgear cards: 1	2	3	Elastics 1	2	3
A	10	11	10	20	20	20
B	12	10	10	24	24	8
C	11	10	10	20	19	17
D	14	10		18	19	16
E	12			21	21	12
F	14	14	13	20	20	20
G	14	14	12	24	24	24
H	12	11	11	19	20	19
I	10	9	8	20	12	12
J	13	10		23	23	23
K	11	12	8	19	18	16
L	13	10		24	24	24
M	11			21	23	23
N	13	14	14	21	19	20
O	13	9		13	10	13
P		19	17	24	24	24
Q	14	14		15	20	23
R	10	12	11	22	22	22
S	14	14	14	23	22	21
T	13	13	12	22	16	22
U	11	12	11	24	23	23
V	13	13		21	21	21
W	8	9		22	21	22
X	15	14	8	21	21	21
Means	12.2	12.0	11.3	20.9	20.3	19.4
SD	1.69	2.37	2.44	2.75	3.47	4.34

2. Interrogation Admissions (Table 2)

These figures were obtained by the researcher doing the interrogation. They represent the patient's admitted recollection of the "true wearing hours".

Card 1 - The patients reported that the headgear was really worn an average of 9.8 hours a day. The elastics were worn an average of 16.9 hours a day.

Card 2 - During this period the patients reported that the headgear was worn 9.6 hours per day, and the elastics averaged 15.7 hours per day.

Card 3 - The averages reported during this period showed that the headgear was worn 9.1 hours per day, and the elastics 16.6 hours per day.

3. Polygraph Results (Table 3)

Of all the charts checked and evaluated by the expert only five, of the twenty-four subjects, required retesting. Table 3 represents the expert's final evaluation of all subjects regarding the number of hours the elastics and headgear were worn.

Card 1 - The group evaluation indicated that they wore the headgear an average of 9.1 hours per day, and the elastics 15.4 hours.

TABLE 2

Interrogation Admissions
(hours)

SUBJECTS	Headgear cards: 1	2	3	Elastics 1	2	3
A	10	11	10	20	20	20
B	7	5	7	15	13	7
C	11	10	10	19	17	17
D	7	6		9	9	11
E	12			21	21	12
F	5	5	1	12	5	5
G	12	12	11	22	22	22
H	9	8	8	16	16	18
I	10	9	8	11	11	12
J	8	6		20	18	18
K	8	8	8	10	9	9
L	11	10		22	22	22
M	11			16	13	21
N	12	12	12	21	19	20
O	11	9		11	10	10
P		16	15	20	20	20
Q	11	11		5	3	21
R	10	12	11	22	22	22
S	10	9	5	10	15	8
T	12	12	12	21	13	21
U	9	10	10	22	21	21
V	10	10		19	17	19
W	7	8		21	19	22
X	12	12	8	21	21	21
Means	9.8	9.6	9.1	16.9	15.7	16.6
SD	1.93	2.62	3.19	5.10	5.45	5.53

TABLE 3

Polygraph Results
(hours)

SUBJECTS	Headgear cards: 1	2	3	Elastics 1	2	3
A	10	11	10	19	19	19
B	6	5	7	13	13	7
C	10	10	10	16	15	15
D	5	5		7	7	9
E	12			19	19	12
F	5	5	1	11	5	5
G	11	11	11	20	20	20
H	9	8	8	16	16	18
I	10	9	8	11	11	12
J	7	6		20	18	18
K	7	7	7	8	8	8
L	10	10		21	21	21
M	9			13	13	20
N	9	9	10	19	19	20
O	9	9		9	9	10
P		14	14	17	17	17
Q	10	10		5	3	21
R	10	12	11	21	21	21
S	10	9	5	10	15	8
T	11	11	11	20	12	20
U	9	10	10	17	17	17
V	10	10		16	15	16
W	7	8		21	19	22
X	12	12	12	21	21	21
Means	9.1	9.1	8.7	15.4	14.7	15.7
SD	1.94	2.39	2.96	4.95	4.80	5.26

Card 2 - The expert's opinion was that the headgear was on 9.1 hours every day, and the elastics 14.7 hours.

Card 3 - The expert's opinion was that the headgear was on 8.7 hours per day, and the elastics 15.7 hours per day.

In Figure 14 we have graphically shown the results of the tabulations from Table 1, Table 2 and Table 3.

B. Changes in Cooperation as Treatment Progressed

1. Relating to Time Card Reports (Table 4)

Headgear - The only statistical significance was between headgear cards 2 and 3.

The decline of 1.33 hours resulted in a "t" ratio of 2.39 which was significant at the .05 level.

Elastics - No significant difference was found.

2. Relating to Interrogation Admissions (Table 5)

Headgear - No significant difference was found.

Elastics - Between card 1 and card 2 (-1.25 hours), there was a significant difference at the .05 level.

3. Relating to Polygraph Results (Table 6)

Headgear - No difference of any significance was noted.

Elastics - Nothing of significance was found.

COMPOSITE COOPERATION CHART

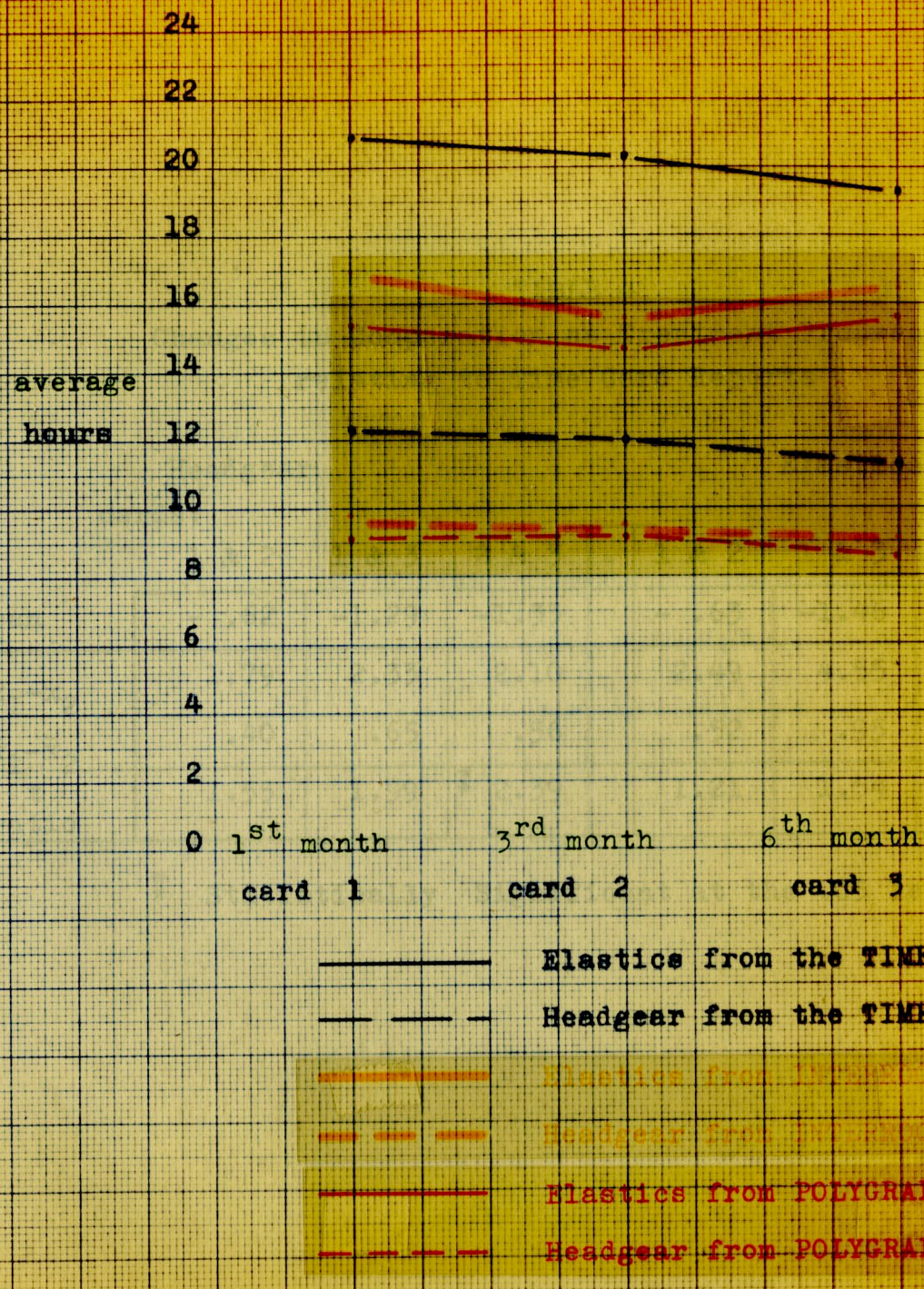


figure 14

TABLE 4

Changes in Cooperation as Treatment Progressed relating to Time Card Reports

	Headgear cards:				Elastics		
	1 & 2	1 & 3	2 & 3		1 & 2	1 & 3	2 & 3
Mean	- .62	-1.29	-1.33		- .63	-1.46	- .83
$S_{x_1-x_2}$	1.79	2.33	2.10		2.49	4.55	4.14
$S_{\bar{x}_1-\bar{x}_2}$	.40	.65	.56		.52	.95	.86
t ratio	1.55	1.99	** 2.39		1.21	1.54	.97

** Statistically Significant at the .05 level

TABLE 5

Changes in Cooperation as Treatment Progressed relating to Interrogation Admissions

	Headgear				Elastics		
cards:	1 & 2	1 & 3	2 & 3		1 & 2	1 & 3	2 & 3
Mean	- .33	-1.14	-1.00		-1.25	- .29	+ .96
$S_{x_1-x_2}$	1.10	2.17	1.95		2.72	4.56	5.12
$S_{\bar{x}_1-\bar{x}_2}$	.25	.60	.52		.57	.95	1.07
t ratio	1.32	1.90	1.92		** 2.19	.31	.89

** Statistically Significant at the .05 level

TABLE 6

Changes in Cooperation as Treatment Progressed relating to Polygraph Results *

	Headgear cards:				Elastics		
	1 & 2	1 & 3	2 & 3		1 & 2	1 & 3	2 & 3
Mean	0.00	- .62	- .53		- .71	+ .29	+1.00
$S_{x_1-x_2}$	.75	1.88	1.91		2.40	4.32	4.97
$S_{\bar{x}_1-\bar{x}_2}$	.17	.54	.52		.50	.90	1.04
t ratio	0.00	1.15	1.02		1.42	.32	.96

* None were Statistically Significant at the .05 level

A summary of these three periods indicates that there is no clear cut evidence of any cooperation variations concerning time changes.

For a composite comparison of these three cards observe Figure 14.

C. Comparisons

1. Between Time Card Reports and Interrogation Admissions (Table 7)

Headgear - In reference to the period covered by card 1; the time card estimates average 2.44 hours higher than the average figure given under interrogation. This is significant at the .01 level. Regarding the period covered by card 2, again the average time card estimates was 2.41 hours higher than the average report during interrogation. This is significant at the .01 level. The period covered by card 3, indicated the groups average original figure was 2.20 hours higher than the average figure given at interrogation. This was not quite significant at the .05 level.

Elastics - A significant difference was found between each of the original time card averages and the corresponding interrogation average. Card 1 indicated a difference of 3.96 hours; card 2 had a difference of 4.58 hours; and card 3 showed a

TABLE 7

Comparison

between

Time Card Reports and Interrogation

	Headgear cards:			Elastics		
	1 & 1	2 & 2	3 & 3	1 & 1	2 & 2	3 & 3
Mean	-2.44	-2.41	-2.20	-3.96	-4.58	-2.79
$S_{x_1-x_2}$	3.36	3.25	4.11	5.55	6.63	4.79
$S_{\bar{x}_1-\bar{x}_2}$	.72	.71	1.10	1.17	1.38	.99
t ratio	** 3.39	** 3.39	2.00	** 3.39	** 3.32	** 2.82

** Statistically Significant at the .01 level

difference of 2.79 hours. All of these three time periods showed a statistically significant difference at the .01 level.

2. Between Interrogation Admissions and Polygraph Reports (Table 8)

Headgear - The period covered by card 1, indicates that the average interrogation result was .74 hours higher than the average determined using the polygraph. This difference was significant at the .01 level. Card 2 shows the average estimate reached by polygraphic interpretation, was .46 hours lower than the time card. This was significant at the .01 level. The third card shows a difference of .33 hours from the average interrogation, for this period, and the polygraph evaluation. This is not significant at the .05 level.

Elastics - In reference to the period covered by card 1; the difference between average interrogation admission and average polygraph result was 1.50 hours. This was enough to be significant at the .01 level. The periods covered by cards 2 and 3, both indicate a difference of .96 and .92 hours respectively. Both of these values are enough to be significant at the .01 level.

The statistical significance between the polygraph and interrogation admissions should be noted carefully, as the

TABLE 8

Comparison

between

Interrogation Admissions and Polygraph Results

	Headgear cards:			Elastics		
	1 & 1	2 & 2	3 & 3	1 & 1	2 & 2	3 & 3
Mean	- .74	- .46	- .33	-1.50	- .96	- .92
$S_{x_1-x_2}$	1.11	.90	.67	1.98	1.47	1.48
$S_{\bar{x}_1-\bar{x}_2}$	.23	.19	.18	.41	.31	.31
t ratio	** 3.22	** 2.48	1.83	** 3.07	** 3.10	** 2.97

** Statistically Significant at the .01 level

magnitude of the overall hourly difference of these two combinations is much less than between time card reports and interrogation.

All of these comparisons may be seen graphically in Figure 14.

3. Between Sexes

a. Relating to Time Card Reports (Table 9)

Regarding both headgear and elastics, during all three periods tested, there were no differences that were statistically significant.

b. Relating to Interrogation Admissions (Table 10)

No significant differences noted in any treatment period for either headgear or elastics. That is, differences of this magnitude occur by pure chance.

D. Recording Reliability

The index used for this determination is "patient recording reliability" which is defined as the figure given under interrogation expressed as a percent of the figure subjects gave on the original time card. Figure 15 shows the relative frequency with which various degrees of reliability occurs. This is not a "cooperation" graph, as it relates only to how honest the

TABLE 9

Comparison
of
SEX DIFFERENCE relating to Time Card Reports *

		Mean	SD	N
Headgear				
card 1	boys	12.0	1.86	11
	girls	12.4	1.50	12
card 2	boys	11.8	1.90	11
	girls	12.3	2.69	12
card 3	boys	11.1	2.17	7
	girls	11.4	2.64	8
Elastics				
card 1	boys	21.6	1.55	11
	girls	20.2	3.26	13
card 2	boys	20.0	3.46	11
	girls	20.5	3.36	13
card 3	boys	20.5	3.35	11
	girls	18.5	4.78	13

* None were Statistically Significant at the .05 level

TABLE 10.

Comparison
of
SEX DIFFERENCE relating to Interrogation Admissions *

		Mean	SD	N
Headgear				
card 1	boys	9.6	2.19	11
	girls	10.0	1.63	12
card 2	boys	9.5	2.50	11
	girls	9.7	2.77	11
card 3	boys	9.0	3.61	7
	girls	9.0	2.59	8
Elastics				
card 1	boys	18.3	4.58	11
	girls	15.8	5.25	13
card 2	boys	16.1	5.44	11
	girls	15.3	5.37	13
card 3	boys	17.5	5.73	11
	girls	15.9	5.25	13

* None were Statistically Significant at the .05 level

PATIENT RECORDING RELIABILITY
Determined by the Difference Between
Time Card Reports and Interrogation
Results

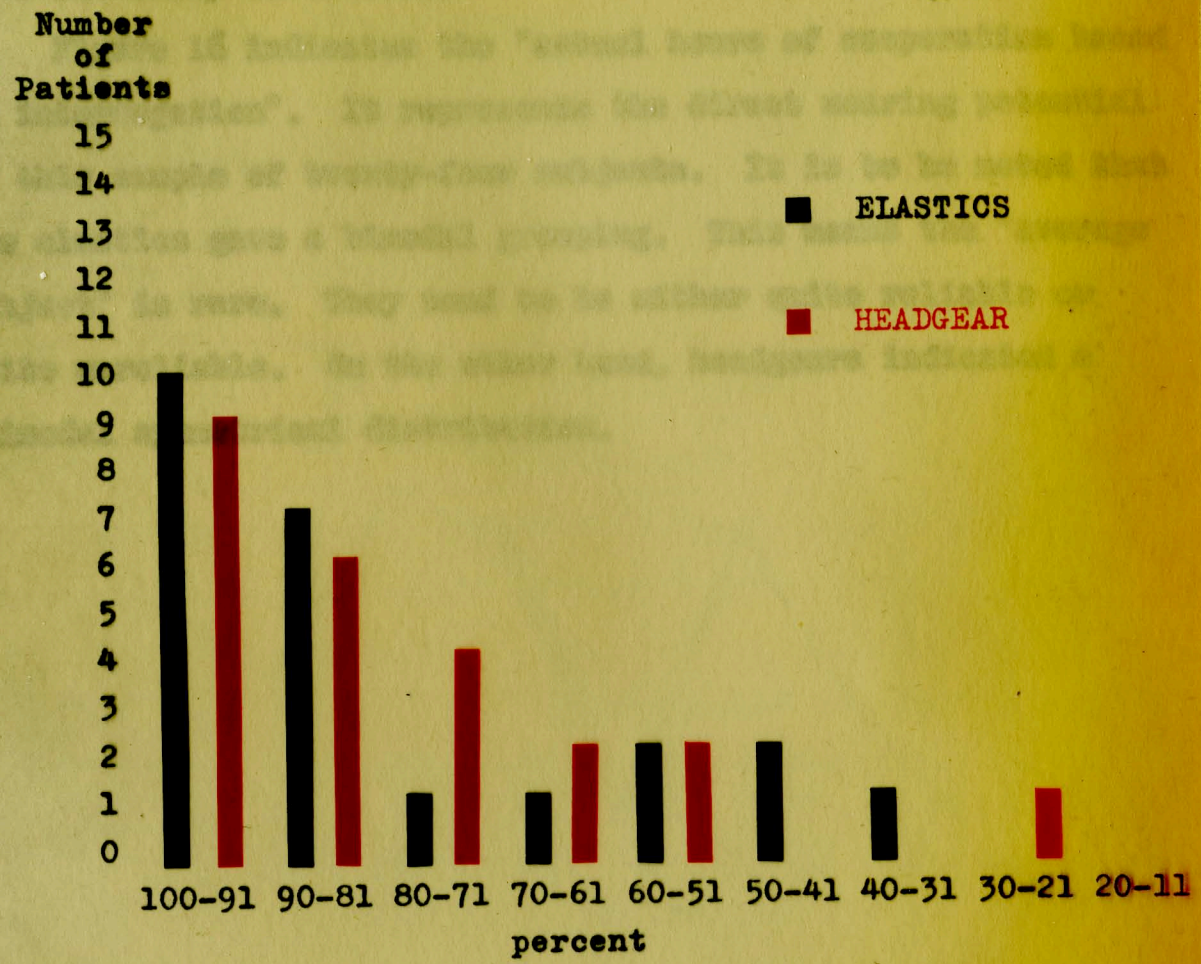


figure 15

subjects were. It is to be noted that this is an extremely skewed distribution. Most subjects were relatively reliable (i.e. 80% or better) but some of the ones who were unreliable were extremely unreliable.

Figure 16 indicates the "actual hours of cooperation based on interrogation". It represents the direct wearing potential of this sample of twenty-four subjects. It is to be noted that the elastics gave a bimodal grouping. This means the "average subject" is rare. They tend to be either quite reliable or quite unreliable. On the other hand, headgears indicated a unimodal symmetrical distribution.

Actual Hours of Cooperation
by Subjects Own Admission During
Interrogation

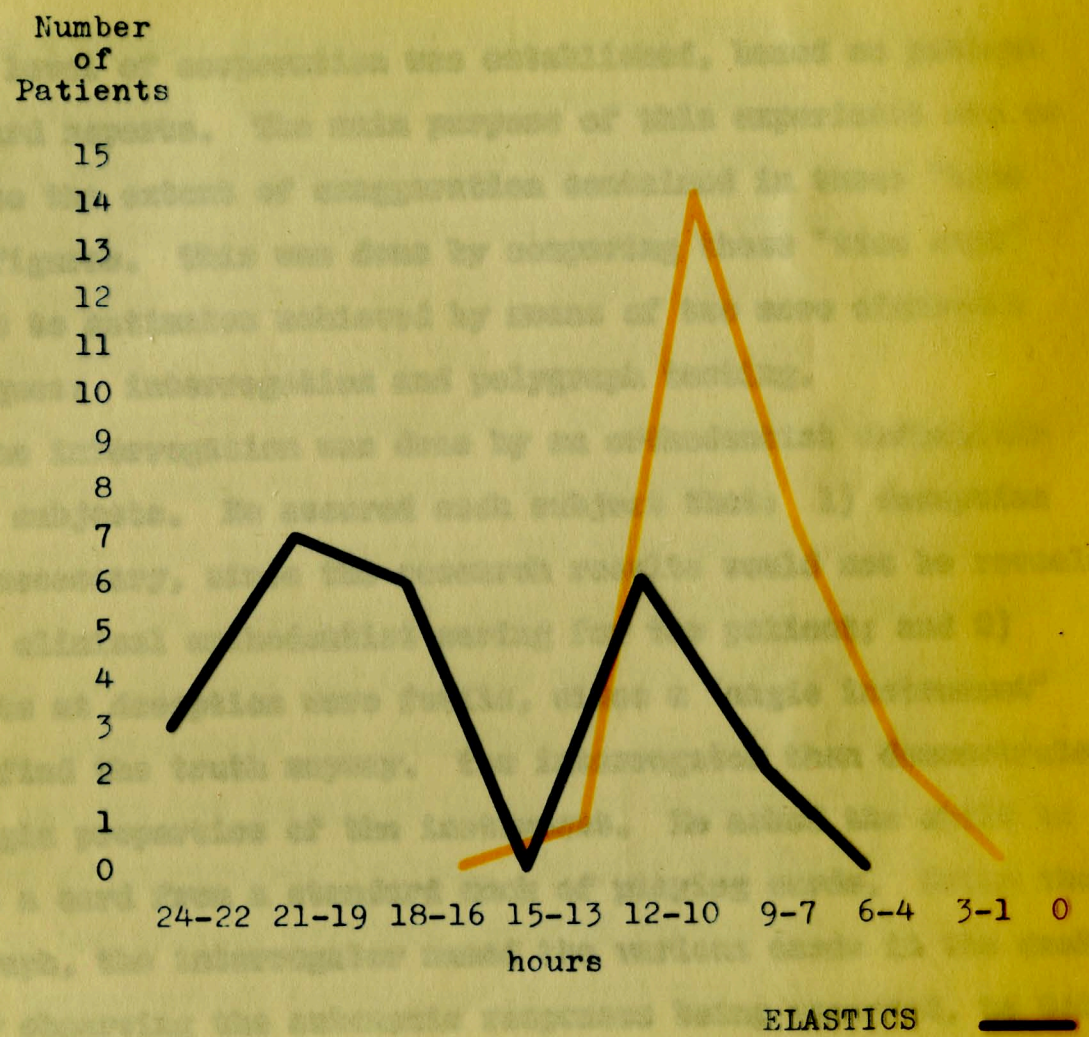


figure 16

CHAPTER V

Discussion

A level of cooperation was established, based on patient time card reports. The main purpose of this experiment was to estimate the extent of exaggeration contained in these "time card" figures. This was done by comparing these "time card" figures to estimates achieved by means of two more elaborate techniques: interrogation and polygraph testing.

The interrogation was done by an orthodontist unfamiliar to the subjects. He assured each subject that: 1) deception was unnecessary, since the research results would not be revealed to the clinical orthodontist caring for the patient; and 2) attempts at deception were futile, since a "magic instrument" would find the truth anyway. The interrogator then demonstrated the magic properties of the instrument. He asked the child to select a card from a standard deck of playing cards. Using the polygraph, the interrogator named the various cards in the deck, and by observing the autonomic responses being recorded, he told the child which card had been selected originally. To insure there was no possibility of a mix-up, the interrogator used a

marked deck. Following this impressive demonstration, the interrogator questioned the child about the figures on the "time cards".

The estimates achieved by this method differed considerably from the original "time card" estimates. Average time card estimates were 11.8 hours per day for headgears and 20.3 hours per day for elastics. Average interrogation estimates were 9.2 hours a day for headgears and 16.4 hours a day for elastics.

This does not mean that the clinician should, or indeed could, do a similar interrogation. As an experiment, two cases were selected where the children had already admitted to the interrogator that the figures on the time cards were exaggerated (300-400%). The investigator asked the clinical orthodontist to question the children and estimate the cooperation levels. The clinical orthodontist was permitted to see the original "time card", but was <u>not</u> permitted to see the results of the interrogation or polygraphic testing. Despite the fact that both children had already admitted 300-400% exaggeration factors to the interrogator, neither would admit any substantial exaggeration to the clinical orthodontist. Common sense would indicate that a thief wouldn't normally volunteer information concerning his actions to the victim; the same should apply to

patients who have made incorrect entries on their cooperation charts.

The polygraph testing was also done by the same research orthodontist who did the interrogation. The questions were prepared with the aid of professional polygraph examinors. The resulting polygraph charts were interpreted by an experienced polygraph examinor. In five cases, the polygraph examination was repeated. The estimates achieved through the use of the polygraph were lower than those obtained through interrogation (statistically significant at the .01 level), but the differences in these estimates were of small magnitude.

Orthodontists have expressed the belief that cooperation level changes in different phases of treatment. While this may be true in individual cases, there is no indication that there are any systematic trends during this six month test period. Orthodontists have also expressed the belief that there is a sex difference in cooperation levels. There is no indication of any sex difference in this data.

When a frequency polygon is made depicting the relative frequencies of the various cooperation levels, it is noted that elastics cooperation follows a bimodal distribution. This means that patients either accept the elastics and are "very reliable"

wearers, or reject them and are "unreliable" wearers, with few patients in the midregion. This is not the case for headgear cooperation, where the distribution is unimodal and symmetrical.

The frequency polygon for "patient recording reliability" is extremely skewed. This means that the "average" is a misleading figure. Most of the patients were quite reliable in completing their time cards. But some of those who exaggerated tended to greatly exaggerate.

The reader should be made aware of the selectivity of this sample of twenty-four patients. Being in a teaching institution for treatment, this allows the orthodontist to put a great deal of pressure on the patients to cooperate in every zone of treatment. This type of pressure isn't usually applied in most private practices. The point to be made is that this is a very selective group, and could be considered an "upper level" cooperative prone group.

CHAPTER VI

Summary and Conclusions

A. Summary

As orthodontists, we know the tremendous importance that patient cooperation plays in treatment. For some unusual reason this area of "patient assistance" has not been investigated before in any detail. In this study, an estimate of the cooperation level was first established by the patients thru record cards. This recorded level was then compared to interrogation and finally polygraph cooperative levels.

Twenty-four patients: eleven boys, and thirteen girls were selected for this study. They were randomly selected for this study from the orthodontic clinic of Loyola University School of Dentistry. They were all between eleven and fifteen years of age. These patients represented all forms of malocclusions and had been under treatment for three months at the beginning of home record keeping. All were wearing headgears and elastics.

Following six months, of daily reporting the number of hours the elastics and headgears were worn, these patients were

subjected (without previous warning), to interrogation and polygraphic testing.

As it was mentioned earlier, the presence of a third party doing the interrogation, was a definite advantage. He was able to convince them that their answers would go no further, so why not tell the complete truth? Later, he would further convince them of the "futileness of lying" as the polygraph was his "donkey's tail", and he would surely find the correct answers anyway.

The results obtained were all evaluated by statistical methods. They were tabulated in such a way that any tendencies or patterns would become evident.

B. Conclusions

1. A conventional level of cooperation was established using time cards. This level, when averaged, was 11.8 hours per day for headgears, and 20.3 hours per day for elastics.

2. Dramatically lower estimates were obtained when the patients were interrogated. This "interrogation level" established the average headgear was being worn 9.2 hours per day, and the elastics were averaging 16.4 hours each day.

3. This "interrogation level" is slightly high when compared to the results obtained from the polygraph. This "polygraph

level' gives the headgear averages at 9.0 hours and 15.3 hours each day for the elastics.

4. It was shown that there were no systematic changes in co-operation level as treatment progressed.

5. It was determined that cooperation levels are not influenced by sex.

6. The best estimates of elastics cooperation gave a bimodal distribution. This indicates that the patients were either 'very reliable' or very unreliable'. Headgears gave a unimodal distribution.

7. The 'patient recording reliability' yielded a skewed distribution as most of the patients were reliable, but a few were very unreliable.

BIBLIOGRAPHY

Ando, Y. Psychological Responses of Patients in Orthodontic Treatment. Journal of Nihon University, 3:134-139, March 1961

Auther, R. O. and Caputo, R. R. Interrogation for Investigators. William C. Capp and Associates, New York 36, N. Y. 1959.

Barlow, Peter Barlow's Tables. 4th Edition, Chemical Publishing Co. Inc., New York, N. Y. 1954.

Batson, H. C. An Introduction to Statistics in the Medical Sciences. Burgess Publishing Co., Minneapolis 1956.

Bell, J. O. Psychological Aspects of Dental Treatment of Children. Journal of Experimental Education, Madison, Wisconsin. 52-63, 1943.

Best, C. H. and Taylor, N. B. The Physiological Basis of Medical Practice. 5th Edition, The Williams and Wilking Co. Baltimore 1950.

Business Uses of the Lie Detector. Business Week, June 1960.

Clendening, L. The History of Certain Medical Instruments. Annals of Internal Medicine. 4: 176-189, 1930.

Darrow, Chester A. Galvonic Skin Reflexes and Blood Pressure Reactions in Psychotic States. Archieves Neurology and Psychology. 32: 273-299, August 1934.

Fallmer, W. F. The Polygraph. A paper presented at Michigan State University. August 1961.

Garrett, H. E. Elementary Statistics. 2nd Edition, David McKay Company, Inc., New York 1962.

Goss, C. M. Gray's Anatomy of the Human Body. 27th Edition, Lea and Febiger, Philadelphia, 1959.

Guyton, A. C. Textbook of Medical Physiology. W. B. Saunders Co., Philadelphia and London 259-271, 1961.

Hebb, D. O. A Textbook of Psychology. W. B. Saunders Co., Philadelphia and London, 1958.

Inbau, F. E. and Reid, J. Lie Detection and Criminal Interrogation. The Williams and Wilkins Co. Baltimore, 1953.

Jones, D. S. Concepts of Neuroanatomy. Lecture Notes, Loyola University, Revised edition, 1963.

Jost, H. The Use of Polygraphic Techniques in Psycho-Physiological Research and Clinical Psychology. Associated Research, Inc. Chicago, 1953.

Larson, Hanley and Keeler Lying and Its Detection. Univ. of Chicago Press, Chicago 65-93, 1932.

Leonard, V. A. Academy Lectures on Lie Detection. Charles Thomas publisher, Springfield, Ill. 1957.

Lewis, T. M. and Law, D. B. Investigation of Certain Autonomic Responses of Children to a Specific Dental Stress. Journal of the Amer. Dent. Assoc., 57: 769-777, Dec. 1958.

Marston, W. The Lie Detection Test. Richard R. Smith, New York 1938.

Roder, R. E., Lewis, T. M. and Law, D. B. Physiological Responses of Dentists to the Presence of a Parent in the Operatory. Journal of Dentistry for Children, 263-270, Fourth Quarter, 1961.

Trovillo, P. V. A History of Lie Detection. Journal of Criminal Law and Criminology, 29: 848-881, 1939.

University of Chicago Press. The Lie Detector, Its History and Development. Journal of the Michigan State Medical Society, October, 1932.

Wang, G. H. The Galvanic Skin Reflex. Part 1 American Journal of Physical Medicine 36: 295-320.

Wellman, F. L. The Art of Cross Examination. 4th Edition Collier books, New York, N.Y.

Wyburn, G. M. The Nervous System. Academic Press, London and New York, 1960.

GLOSSARY FOR POLYGRAPH TERMINOLOGY

Apnea - a temporary arrest in respiratory activity.

Baseline - the lowest points of the recording cycles.

Cardiograph - an instrument for recording the force and form of the heart's movements.

Diastole - the heart is relaxed, following the forceful exit of the blood from the heart; allowing the cardio recording pen to "come down" on the chart.

Dicrotic Notch - following systole, the backward flowing blood "bounces off" the valves and starts to flow forward again. This temporary forward movement of the blood is reflected in the tracing as a very short horizontal line.

Galvanograph - a hand electrode instrument for registering very minute electric currents.

Pneumograph - an instrument for registering the respiratory movements.

Systole - the heart contracts forcing the blood into the aorta; forcing the cardio recording pen "upward" on the chart.

APPROVAL SHEET

The thesis submitted by Dr. Jack G. Mann has been read and approved by members of the Departments of Anatomy and Oral Biology.

The final copies have been examined by the Director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the thesis is now given final approval with reference to content, form, and mechanical accuracy.

The thesis is therefore accepted in partial fulfillment of the requirements for the Degree of Master of Science.

March 24 1964
Date

Joseph R Jurnak
Signature of Adviser